IJESRT
INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

Results of Comparative Analysis of BPSK & QPSK using Equalized OFDM

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Abstract

The main aim of the communications system is to provide a wide variety of communication services such as high speed data, minimum ISI & ICI as we all well aware about it. In this aspect the OFDM communication system is a one of the best option for high bandwidth data transmission, by converting the wideband signal into a parallel narrow band signals for parallel transmission. This multicarrier modulation has been used n modem for both radio and telephone channels It has also been adopted as a standard for digital audio broadcast application.

Attenuation increases rapidly the characteristics makes it extremely difficult to achieve a high transmission rate with single modulated carrier and equalizer at a receiver. On other hand multicarrier modulation with optimum power distribution provides the potential for a higher transmission rate. Multicarrier system that employs the FFT algorithm to synthesis the signal at the transmitter and to demodulate the received signal at the receiver. FFT is simply the efficient computational tool for implementing the DFT.

In this paper, we present the bit error probability (BEP) performance analysis of Rayleigh Fading Channel with BPSK and QPSK modulation technique and also having results of figure of both BPSK & QPSK modulation techniques. This paper also presents a systematic approach for analyzing the bit-error probability (BEP) of equalized OFDM signals in Rayleigh fading. The data is modulated, encoded, spread and transmitted through a frequency selective Rayleigh fading channel. And all that result we got, that are obtained after the study and coding in MATLAB 7.4. It is an interactive, integrated, environment for numerical computations, for scientific visualizations.

Keywords: BEP Analysis, DFE, FFT, Rayleigh Fading,

Introduction

The effectiveness of Orthogonal Frequency Division Multiplexing (OFDM) as a modulation technique for wireless radio applications. Several of the main factors affecting the performance of a OFDM system were measured, including multipath delay spread, channel noise, distortion (clipping), and timing requirements. The performance of OFDM was assessed by using computer simulations performed using MATLAB, and practical measurements.

OFDM was found to have total immunity to multipath delay spread provided the reflection time is less than the guard period used in the OFDM signal. In fact, multipath signals lead to a strengthening of the received signal, improving the performance.

Simulation of wireless channels accurately is very important for the design and performance evaluation of wireless communication systems and components. Fading or loss of signals is a very important phenomenon and must be well understood by all engineers related to the Wireless Communications Field. That leads us to the fading models which try to describe the fading patterns in different environments and conditions. Although no model can 'perfectly' describe an environment, they strive to obtain as much precision as possible. The better a model can describe a fading environment, the better can it be compensated with other signals, so that, on the receiving end, the signal is error free or at least close to being error free. This would mean higher clarity of voice and higher accuracy of data transmitted over wireless medium.

When simulating the wireless channel for mobile and macro cellular communications, it is usually assumed that the fading process is a Rayleigh fading process.

Background

As we all know that MATLAB stands for **MAT**rix **LAB**oratory. It is developed by The Mathworks, Inc. (http://www.mathworks.com). It is an interactive, integrated, environment for numerical computations, for scientific visualizations [4].

It is a high-level programming language. Program runs in interpreted, as opposed to compiled, mode. Programming language is based (principally) on matrices, But it is slow (compared with FORTRAN or C) because it is an interpreted language, *i.e.* not pre-compiled. Automatic memory management, i.e., you don't have to declare arrays in advance) [4].

It reduces program development time than traditional programming languages such as Fortran and C.

MATLAB has many application-specific toolboxes which supports development of high level test applications.

- **Cyclic prefix**

Cyclic prefix is a crucial feature of OFDM used to combat the inter-symbol-interference (ISI) and inter-channel-interference (ICI) introduced by the multi-path channel through which the signal is propagated. The basic idea is to replicate part of the OFDM time-domain waveform from the back to the front to create a guard period. The duration of the guard period Tg should be longer than the worst-case delay spread of the target multi-path environment.

- **Rayleigh Fading**

The Rayleigh fading model is particularly useful in scenarios where the signal may be considered to be scattered between the transmitter and receiver. In this form of scenario there is no single signal path that dominates and a statistical approach is required to the analysis of the overall nature of the radio communications channel.

However there will be very many objects around the direct path. These objects may serve to reflect, refract, etc the signal. As a result of this, there are many other paths by which the signal may reach the receiver.

When the signals reach the receiver, the overall signal is a combination of all the signals that have reached the receiver via the multitude of different paths that are available. These signals will all sum together, the phase of the signal being important. Dependent upon the way in which these signals sum together, the signal will vary in strength. If they were all in phase with each other they would all add together. However this is not normally the case, as some will be in phase and others out of phase, depending upon the various path lengths, and therefore some will tend to add to the overall signal, whereas others will subtract.

The Rayleigh fading model can be used to analyze radio signal propagation on a statistical basis. Accordingly all these examples are ideal for the use of the Rayleigh fading or propagation model.

- **DFE with zero forcing feedforward section**

Figure 1. shows the results for decision feedback equalizers (DFEs) with a varying number of feedforward stages. In other words, decision feedback was used to subtract out the interference from the preceding symbol, linear equalization was used to reduce the interference from the following symbols. The feedforward stages were designed to meet the zero forcing criterion

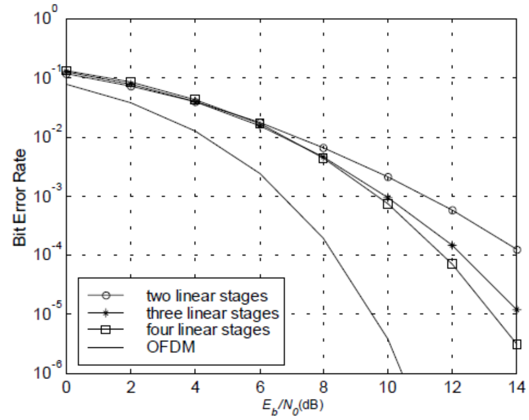

Fig.1 BER for decision feedback equalizers with linear zero forcing feedforward Section.

- **DFE with zero forcing feedforward section and error correction across a symbol**

The results for the DFE are much better than for the linear equalizer, but the degradation compared with normal OFDM, or PCC-OFDM with no overlap is still more than 3dB. In this case the errors in decoding each subcarrier pair are being fed back and as will be shown, this contributes significantly to the BER. One way toreduce this error propagation is to use an error correcting code across each symbol. This would reduce significantly the probability of error for each subcarrier pair and hence the probability of error propagation. Figure 2 shows the results where the correct data values are used in the feedback. The performance is improved considerably and the BER is now within approximately 1.5dB of that for normal OFDM.

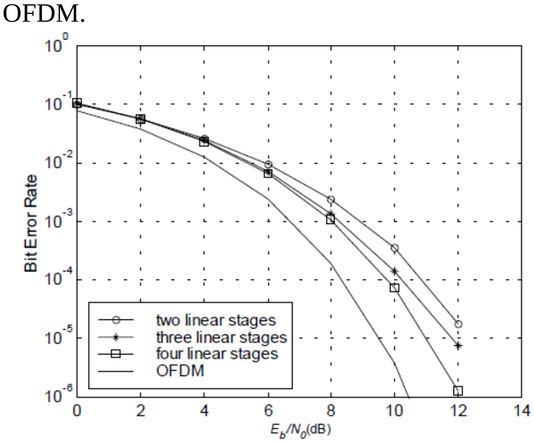

Fig. 2 BER for decision feedback equalizers with linear zero forcing feedforward section. Correct decisions fed back.

- **Other equalizer structures**

By designing the feedforward section using the minimum mean square error criterion (MMSE) further improvements should be possible. The design of the MMSE section must take into account that the noise at the input to the equalizer is not white. The weighting and adding section introduces some correlation between the noise values in adjacent vectors. Alternatively a maximum likelihood sequence estimator (MLSE) could be designed. Matheus [8] considered this approach for OFDM with Gaussian windowing but it is computationally complex.

Proposed Work

Source data for this simulation is taken from a random matrix based on the our choice. The data will then be converted to the symbol size (bits/symbol) determined by the choice of BPSK from provided by this simulation. The converted data will then be separated into multiple frames by the OFDM transmitter. The OFDM modulator modulates the data frame by frame. Before the exit of the transmitter, the modulated frames of time signal are cascaded together along with frame guards inserted in between as well as a pair of identical headers added to the beginning and end of the data stream. The communication channel is modeled and amplitude clipping effect.

The receiver detects the start and end of each frame in the received signal by an envelope detector. Each detected frame of time signal is then demodulated into useful data. The modulated data is then converted back to 8-bit word size data used for generating an output data of the simulation.

Result and Analysis

In this work we have developed a model and also developed the MATLAB program for test algorithm.

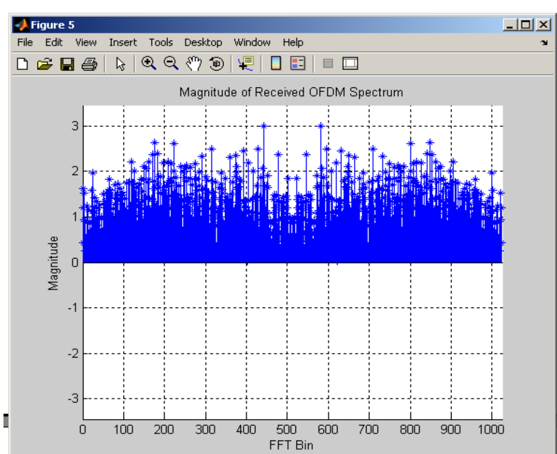

Fig.3 Magnitude of received OFDM spectrum

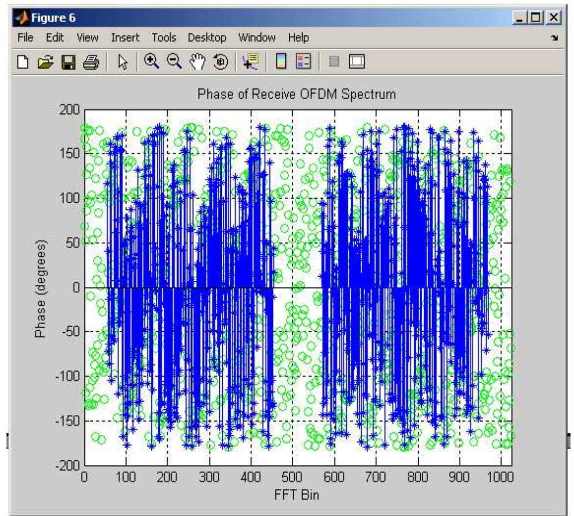

Fig. 4 MATLAB Output – Flat Fading

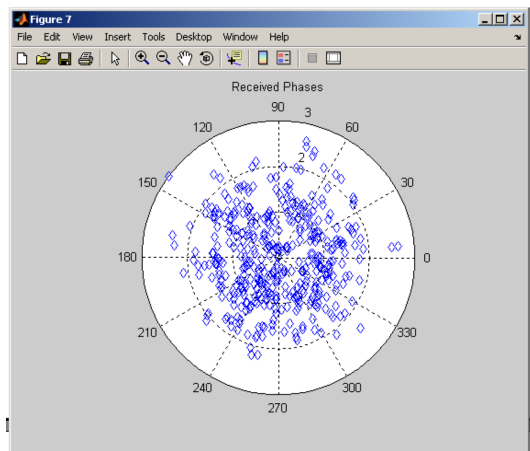

Fig.5 MATLAB Output BPSK – Rayleigh Fading

Figure shows the simulation results.
For Qpsk

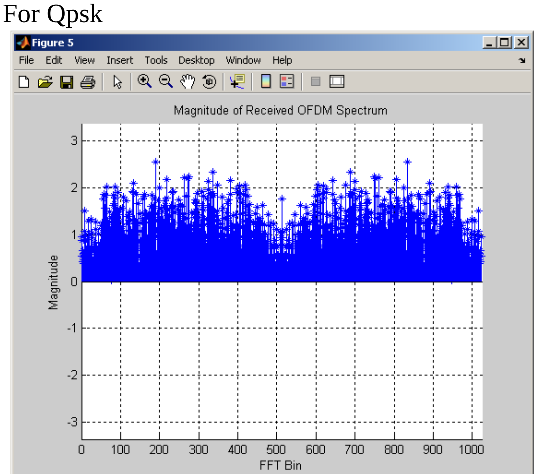

Fig. 6 Magnitude(QPSK) of received OFDM

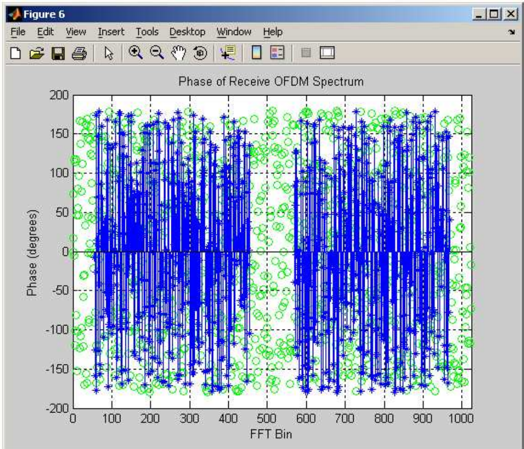

Fig .7 Phase of QPSK of received OFDM

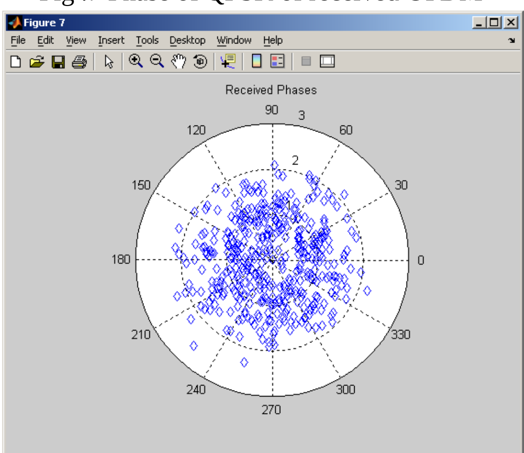

Fig. 8 Received Phases of QPSK

Conclusion

In this paper an accurate framework has been proposed to analytically assess the performance of equalized OFDM systems. As shown in fig.5 & fig.8 that resultant phase of BPSK and QPSK modulation technique, QPSK is better than BPSK system. In QPSK system it is also observed that as the SNR increases BER reduces after three or four trials as compare to BPSK with the same setting and scenarios of matlab code.

There are some of the results of the QPSK system which contain Bit Error Rate information summary. this summary cover total number of error bit and BER and one of the important parameter that is average phase error measured in degree trials/experiments with different SNR from 1to 10.

BER Detail

Summary of Errors
Total number of errors = 94869 (out of 262144)
Bit Error Rate (BER) = 36.189651%
Average Phase Error = 41.883322 (degree)
SNR 1

Summary of Errors
Total number of errors = 79823 (out of 262144)
Bit Error Rate (BER) = 30.450058%
Average Phase Error = 36.976441 (degree)
SNR 2

Summary of Errors
Data loss in this communication = 0.054932% (144 out of 262144)
Total number of errors = 66732 (out of 262000)
Bit Error Rate (BER) = 25.470229%
Average Phase Error = 33.288603 (degree)
SNR 3

Summary of Errors
Total number of errors = 49710 (out of 262144)
Bit Error Rate (BER) = 18.962860%
Average Phase Error = 28.147301 (degree)
SNR 4

Summary of Errors
Total number of errors = 14236 (out of 262144)
Bit Error Rate (BER) = 5.430603%
Average Phase Error = 18.615362 (degree)
SNR 8

Summary of Errors
Total number of errors = 6571 (out of 262144)
Bit Error Rate (BER) = 2.506638%
Average Phase Error = 14.503965 (degree)
SNR 10

The bit error probability (BEP) performance analysis of Rayleigh Fading Channel with BPSK and QPSK modulation technique and, we also notice that channel fading may cause inter channel interference (ICI) amongst sub channels. By modeling the ICI as an equivalent Gaussian noise, we can also obtain an estimation of the BEP performance by adding an equivalent variance term, , the variance of the ICI, to the corresponding BEP expression, if the variance can be evaluated.

Future Scope

This schemes are well characterized and elobrate. performance and of that bit error probability can be increased by reducing SNR and in future it may provide excellent advanced features if this all experiment we performed with WiMax Physical layer in future.

QAM scheme can efficiently improved the performance when transmission over a flat fading channel. It is found that the proposed ofdm based adaptive QAM system outperform other complexity system on spectral efficiency. On other hand we can use CDMA with OFDM. MC-CDMA spreads transmitted data only along frequency domain, whereas MC-DC-CDMA spreads transmitted data only a long time domain. In the case of TFL-CDMA, transmitted data will be spread along both frequency and time domain.

And there are lots of techniques we can use for reducing BEP, ISI & BER.

Apart from this we can easily reduce BER by increasing SNR in MATLAB parameter and changes will see in resultant figure o received phase of received OFDM signal. This is assumed that this phase will be compressed as SNR is increased.

we can evaluated the performance of OFDM system using BPSK and QPSK with OFDM using Generalized Gamma fading distribution. Theoretically it is expected hat Graphical results show the improvement in OFDM-BPSK and –QPSK system compared to its performance in Nakagami-m fading channel.

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